

# **NASA Range Safety Program 2006 Annual Report**

## **EMERGING TECHNOLOGY EASTERN RANGE (ER) INSTRUMENTATION UPDATES**

The Eastern Range is the launch head at Cape Canaveral Air Force Station, which also supports Kennedy Space Center launches. Range Management activities are hosted at Patrick Air Force Base under the command of the 45<sup>th</sup> Space Wing. Downrange sites include Jonathan Dickinson Missile Tracking Annex and Antigua, Argentia, and Ascension stations. In the context of space launch operations, the Eastern Range includes all of the surrounding air, sea, and land space that is within the range of any particular launch vehicle. The Eastern Range is not part of NASA but supports NASA activities.

### **Primary Objective of the Eastern Range**

The primary objective of the Eastern Range is to provide for the safety of the public during launch operations. The activities and resources to ensure safety of flight include range instrumentation, infrastructure, and scheduling required to support and ensure that space and ballistic launches and other operations are appropriately supported.

The Eastern Range Range Safety Program uses instrumentation that is comprised of legacy and state-of-the-art technologies to ensure launch mission safety, launch area safety, and launch complex safety. Range instrumentation is primarily at the Florida locations of Cape Canaveral Air Force Station (missile row shown in the picture at right) and Patrick Air Force Base. The Eastern Range also uses instrumentation from other Department of Defense and NASA agencies to accomplish its mission.

### **Information Provided by Instrumentation**

During launch operations, Eastern Range instrumentation provides vehicle positioning information from radar, vehicle telemetry, and optic tracking systems. Additionally, telemetry also provides vehicle health and status through its data stream. This range safety critical data is shipped via the range communication CORE network to the range safety display strings located in the Range Operations Control Center at Cape Canaveral Air Station. The Range Operations Control Center is shown to the left.

### **Range Safety Strings**

The current range safety strings (the equipment that data flows through) are designated as Flight Operations Version One (FOV1) and located at the Range Operations Control Center. The FOV1 system provides an Eastern Range range safety function and monitors launch vehicle performance. FOV1 consists of two independent systems: FOV1-A and FOV1-B. The systems acquire and process

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instrumentation data from the Eastern Range, NASA, and off-range sites through redundant network paths. Using the instrumentation data, these systems generate flight path and predicted impact point displays similar to the one shown below.

Using these displays, the Mission Flight Control Officer determines the risk based on pre-defined mission rules and, if required, destroys any vehicle that violates those rules. The 45<sup>th</sup> Space Wing Safety Office personnel devise these mission rules to ensure public safety from any errant launch vehicle incident. This is the primary Eastern Range function.

FOV1 is constantly going through upgrade and development efforts. The current follow-on development effort is ongoing and is expected to be completed in early 2007.

### **Post-Detect Telemetry System**

The premier Eastern Range launch vehicle telemetry acquisition system is the post-detect telemetry system. This system provides transport of digital post-detect telemetry data from Eastern Range telemetry sites via the Network CORE System Wide Area Network Interface Units and the microwave and commercial circuits from Jonathan Dickinson Missile Tracking Annex.

Post-detect telemetry system sites include Tel-4 at Kennedy Space Center (shown at left), Jonathan Dickinson Missile Tracking Annex, Antigua, and Ascension. The post-detect telemetry data is transported to the launch customer facilities and the Range Operations Control Center (FOV1) for range safety purposes.

In 2006, the developer updated post-detect telemetry system software to Version 3.1 to provide resolution of deficiency reports generated before post-detect telemetry system initial acceptance.

### **INTEL SATCOM**

The INTELSAT SATCOM System now consists of two separate SATCOM strings: A Side and B Side. SATCOM A, the second phase of the post-detect telemetry system project, was modified in 2006 and implemented at the Eastern Range with the post-detect telemetry system bandwidth, polarization, and modulation format. This new digital communication transport service is the Eastern Range secondary telemetry and transport management system circuit transport carrier from the downrange stations of Antigua and Ascension to the Range Operations Control Center. The control center antenna is shown to the right.

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### **Wide Area Network Interface Units System**

The Network CORE Wide Area Network Interface Units system is the major transport mechanism to Range Safety and telemetry data end users. The CORE provides the communication backbone at Cape Canaveral Air Force Station. The CORE consists of four rings, two OC-48 (red 2488 megabits per second) and two OC-12 (green 622 megabits per second). The communication link to NASA is through the Launch Control Center. The primary nodes are the Range Operations Control Center, XY Facility, Southwest Terminal Building, and the East Terminal Building.

### **Central Telemetry Processing System**

The Central Telemetry Processing System is used for the processing, distribution, and display of Range Safety telemetry data during the powered flight portion of Eastern Range launches. Post-detect data streams into the Central Telemetry Processing System where it undergoes frame synchronization and decommutation. The resulting telemetry parameters are used to generate 4.8 kilobits per second range safety outputs. This 4.8 kilobits per second data is forwarded to the FOV1 system for further processing and display.

### **Replacing the Cyber 860 Mainframe Computers**

Many pre- and post-launch analysis products are produced at the Cape Central Computer Complex. For over 20 years, the Eastern Range has depended on Cyber 860 mainframe computers at the Central Computer Complex to produce launch critical instrumentation analysis and Range Safety flight analysis. These computers and the code that resides in them are outdated in that the hardware is very costly to maintain and software problems are too difficult to fix. Two projects are in progress to replace the 860 Cyber mainframe computers.

**Launch Analysis Production System.** The Launch Analysis Production System project is slated to replace Cyber 860 instrumentation analysis. The project is translating instrumentation analysis computer programs originally written in CDC Cyber FORTRAN to C++ programs that can be hosted on a standard personal computer with a Windows operating system. The project started in April 2005 and is presently scheduled to have the instrumentation analysis programs functioning by mid-2008. Most of the Launch Area Production System hardware has been installed and initial testing is underway.

**Safety Hazards Analysis and Risk Processing.** The Safety Hazards Analysis and Risk Processing project is slated to replace Cyber 860 flight analysis

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automation The project is re-hosting the CDC Cyber FORTRAN flight analysis programs primarily using MATLAB. This system will have open system architecture to allow incorporation of innovations in processor speed and storage capacity without major redevelopment. New commercial off-the-shelf software can be incorporated as “add-on” tools. The architecture will also accommodate the latest built-in analytical tools.

Safety Hazards Analysis and Risk Processing is a two-phased project. Phase 1 will provide the host computer, backup storage, version control tools, and an initial suite of flight analysis software modules. Phase 1 software modules will enable flight analysts to process range user and weather data to produce range safety display backgrounds and range safety risk-based products for launch day support.

Successful completion of Phase 1 will eliminate 45<sup>th</sup> Space Wing reliance on the Cyber 860 mainframes to produce flight analysis launch support products. Phase 1 is on schedule to be completed by October 2007. Phase 2 will provide flight analysis enhancements that were not previously possible due to Cyber 860 limitations and organic software maintenance capability.